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Telecommunications

The telecommunications industry in the United States is far larger than most people realize. To give some idea of its size, shipments of telecommunications equipment in 1981 totaled about $35 billion, and approximately 15,000 telecommunications professionals attend a typical trade show. The industry is characterized by brisk competition and a heady atmosphere of near science fiction innovation. My purpose here will be to highlight some recent developments that have particular significance for libraries.

Electronic Mail

There can't be many people left in this country who have not heard of electronic mail. The newspapers regularly report that Congress has or has not permitted the U.S. Postal Service (USPS) to proceed with various proposed electronic mail services. They also report that giant corporations such as AT&T, General Telephone, Xerox, and others are planning electronic mail services. Behind all this attention, however, there is considerable confusion about just what electronic mail is and what it will mean in practical terms.

Electronic mail is simply the transmission of messages from one human being to another through means that are partly or totally electronic. A telephone call is not electronic mail because "message" in this context implies that the creation and reception are not simultaneous. But if the conventional telephone call does not represent electronic mail, other familiar technologies do, including technologies in use for more than a century.

Facsimile

Facsimile is the transmission of individual images by electronic means. It was first demonstrated in 1843, and by the 1920s was in use in all large newspapers for wirephoto news. There were blithe predictions that facsimile would soon deliver the newspaper to receivers in homes, but that proved impractical, and the wirephoto remained almost the only use of facsimile until the mid-sixties.

In 1966, Magnavox and Xerox jointly developed facsimile equipment suitable for use in a business setting. This meant that small, inexpensive units which used plain paper could be attached to any telephone and could be used by untrained clerical help. This type of device has proved moderately successful, and there are more than 300,000 facsimile units presently in use. A few years ago, when grant money was easier to obtain, several libraries conducted studies to see if facsimile was practical for interlibrary loan work. To summarize, and perhaps oversimplify their findings, users were pleased with the improvement in delivery speed, but not so pleased that they would pay the additional cost that facsimile necessarily entailed. Librarians may yet make substantial use of facsimile, but only after facsimile costs are closer to postage costs.

The preponderance of facsimile units are used to communicate within a single firm or within a narrowly defined industry. For example, the coroners of Arizona are connected by a facsimile network. Ordinarily, all stations in such a network use the same kind of equipment in order to facilitate communication. On the other hand, when facsimile is used as a substitute for paper mail, serious problems of equipment compatibility arise. Two facsimile machines made by different manufacturers often cannot communicate because of differences in speed, resolution, modulation, encoding, protocols, and other technical factors. Thus, the facsimile unit is often regarded as a replacement for the interoffice memo rather than as a full-scale substitute for the U.S. mail.

As the pressure to abandon conventional paper mail grows, there is ample reason to believe that the problems of compatibility will be solved. First, manufacturers are attempting to maintain their competitive edge by designing versatile units that can communicate with other brands and models. Second, international standards organizations such as the International Telephone and Telegraph Consultative Committee (CCITT) have promulgated technical standards which are being widely adopted by facsimile manufacturers. This means, for example, that a facsimile unit designated as CCITT level II can communicate with any other level II machine regardless of brand. Third, facsimile networks exist to permit communication between incompatible units. The network solves the compatibility problem by receiving a message and computer-processing it to

change the speed, resolution, modulation, and so on, before sending it on to the addressee.

Some types of technology are characterized by slow initial acceptance, followed by a period of rapid growth, ended only by market saturation. Black-and-white television is a convenient illustration of this. During the period of rapid growth, the more sets that were sold, the more profitable it became to build television stations. The more television stations that were built, the more attractive it became to own a television set. This cause/effect interrelationship continued until the market for sets was saturated, only to be repeated when color television was introduced. This might easily be the pattern of development for facsimile. The more facsimile units in use, the more beneficial it becomes to acquire facsimile capability. Facsimile units might be as commonplace as office copiers in a decade or so, depending, of course, on postal rates and the growth of other types of electronic mail.

On the other hand, many telecommunications professionals see facsimile as appropriate to only a narrow range of applications. Their argument is that the bulk of information transmitted electronically is in the form of text or tables of letters and numbers. For text, facsimile is dreadfully inefficient. A typical business letter that can take as long as six minutes to send by facsimile can be transmitted in character form in as little as eight seconds. The substantial differences in long-distance charges will favor technologies other than facsimile for routine business communication. Naturally, facsimile will always be used when pictures such as engineering drawings, fingerprints, advertising artwork, and the like are to be transmitted.

Communicating Word Processers

Throughout America, conventional typewriters are being replaced by word processers. It is simply the case that a $15,000 "smart typewriter" makes economic sense if it triples the productivity of $12,000-a-year typist. What does *not* make sense is to create a document on a $15,000 machine, place it in an envelope with a twenty-cent (as of this writing) stamp, and entrust it to the vagaries of the USPS. At least, it doesn't make much sense if the sender and recipient each have communicating word processers (CWPs). With CWPs, a completed document can be transmitted electronically and typed directly on the recipient's machine. This feature is sufficiently attractive that 90 percent of the word processers currently being sold have the communication capability, although only about 30 percent have the necessary communication hardware actually installed.

There are over 100 models of CWPs on the market, and this creates almost exactly the sort of compatibility problems seen in the facsimile

field. Fortunately, the three solutions proposed for facsimile (more versatile machines, standards and networks) are applicable here, and there would seem to be no serious obstacles to the growth of this type of electronic mail.

Electronic Computer-Oriented Mail and Electronic Mail

The USPS has been aware for some time that facsimile, CWPs, computer-based message switching networks, and other forms of electronic mail are seriously eroding their first-class mail revenues. Their own projection is that 23 percent of first-class mail will move electronically by 1985. To counter this threat, the USPS has proposed an initial system, to be known as Electronic Computer-Oriented Mail (ECOM), which would be replaced by a much larger system known as Electronic Mail (EMSS). It is impossible to project with any certainty what form these systems will take, since the U.S. Post Office's action will be determined by Congress rather than by technological considerations. It does seem clear, however, that the rapid growth of electronic mail will force the price of first-class paper mail to levels at which it will be used only when electronic mail is not suitable.

Two-Way Cable

In many parts of the country, the typical home is connected to the outside world by two communication channels. The telephone company provides two tiny copper wires, and the cable television company provides a coaxial cable. For the information scientist, the important distinction between these two channels is that the CATV coaxial cable has about 100,000 times as much information transfer capacity as the telephone line. It has long seemed reasonable to exploit the great channel capacity of CATV for other than one-way transmission of entertainment television. Sensing this, the Federal Communications Commission in 1972 mandated "non-voice return" for all CATV systems. The exact meaning of this requirement was never entirely clear, and a few years later the Federal Communications Commission agreed that existing systems would not be required to add equipment for two-way transmission. All CATV systems installed since that ruling, however, must have the capability of permitting subscribers to communicate "upstream" or back to the head end of the system. Only a small number of CATV systems actually use the two-way capability at present, and they tend to use it in an unsophisticated way. Typically, multiple choices are presented on the screen, and the subscriber "votes" by pressing a numbered key.

Even though two-way CATV has not had a substantial impact yet, the potential for development is great. About 37 million homes in this country

have access to cable (of those with access, only about one-half subscribe), and services such as information retrieval and electronic mail might gain wide usage if attractively priced. A good example of a multiple-use CATV network can be seen at the University of Illinois. CATV is to be installed in all residence halls. This will provide the usual entertainment channels and, in addition, alarm and monitoring systems, access to the University Computer-Assisted Instruction System, access to the computer system that serves the 3000 students taking programming courses in a given semester, and connection to the university's Library Computer System, which will provide access to some 10 million books at this campus and around the state.

The important point here is that CATV will often be installed for the entertainment channels; auxiliary services such as information retrieval will get a "free ride" on the facility, and hence may be attractively priced.

Digital Telephones

Many telephone users see only the most superficial of changes—the introduction of the Mickey Mouse phone—and do not realize that the telephone network behind that phone has been undergoing vast change. One of the most significant changes has been the steady replacement of analog transmission with digital.

In a conventional analog telephone system, the voice causes the diaphragm in the handset microphone to vibrate in the same way that an eardrum would vibrate. The electrical representation of this vibration is transmitted to the distant handset earphone, which converts the electrical signal back into sound. The major flaw in this approach is that, for toll calls, the electrical signal must pass through a great many amplifiers, each of which adds noise, cross-talk (portions of other conversations), and distortion. It is very much as if a document were copied on an office copier, a copy made of that copy, and so on for a dozen or a hundred iterations. Most of us have encountered "copies of copies," and can attest that this process cannot be repeated indefinitely if the results are to be useful.

In a digital telephone, the original speech vibrations are converted into a series of binary numbers that are transmitted to a similar instrument which converts them back into conventional analog form and then into sound. The information passing between the instruments is simply a string of bits represented in the form of electrical impulses. The striking advantage to this approach is that the amplifiers and switching equipment that process these pulses do not add noise or distortion. In principle, a digital signal can be transmitted through an unlimited number of amplifiers with no loss of fidelity. By way of analogy once again, a keypunch can be used to make a copy of a keypunched card, a copy can be made of that

card and so on. If the keypunch does not break down somewhere in the process, the 100th "copy of a copy" will have exactly the same holes punched in it as the original.

The introduction of new telephone technology has always been controlled primarily by economic considerations. As an example, Touch-Tone sets are clearly superior to rotary dial telephones, but with an installed base of 50 million instruments, it simply was not possible to replace all the old telephones overnight. In a similar manner, digital systems are being phased in and will replace older equipment as quickly as economically feasible. The obvious advantage of digital phones is that connections of any distance will be totally free of noise, distortion and cross-talk.

There are very important but less obvious consequences that will accompany the introduction of digital phones. To understand how this new technology will affect data transmission, we must first look at how present-day telephone lines are used to connect computers and terminals.

Most telephone lines presently in use were designed a long time ago to transmit human speech. They do not work well with digital data, and for that reason it is necessary to have a modem between the computer or the terminal and the telephone line. It is the function of the modem at one end of a line to convert the digital information into tones that can be transmitted over a line designed for conversation. The modem at the other end of the line then converts these tones back into digital signals. For complex technical reasons, it is very costly to build modems that will convert digital data at rates above about 2400 bits per second (2400 bits per second is the rate used in the OCLC network, and represents 300 characters per second, or about 3000 words per minute of ordinary text). When higher data rates are essential, computer networks lease other specialized transmission facilities at costs much higher than for voice-grade lines.

With digital telephones, a quite different picture is obtained. The Bell System has standardized digital speech at 56,000 bits per second, the lowest rate that will ensure reasonable fidelity. This means that a digital instrument installed as a "telephone" might also serve for very high-speed data communication. A data rate of 56,000 bits per second is roughly the equivalent of 600 MARC records per minute. It may become commonplace to query remote databases, transfer large quantities of data in a short period, and then do detailed searching offline to minimize line charges.

The word *may* in the preceding sentence needs to be emphasized, because technological innovations of this kind can be enormously disruptive of rate structures. In other words, the Bell System presently offers 56,000-bits-per-second digital service at a price many times the price for ordinary voice-grade service. It may seek to offer digital telephone service in a way that does not undercut its market for specialized data transmission

facilities. On the other hand, in the present climate of intense competition in the telecommunications field, it is simply not credible that a major technical advance could be made without a corresponding reduction in the price of service.

New Telephone Directories

The French PTT (the governmental agency that runs the post office, telephone and telegraph systems) has embarked on an ambitious plan to increase the number of telephones in France from 6 million to 14 million in the space of only four years. As part of its master plan, the PTT plans to eliminate all paper telephone directories by 1995 and so eliminate the printing and distribution of 100,000 tons of paper. It is its belief that providing a simple CRT terminal next to every telephone will be both cheaper and more satisfactory than the continued distribution of paper directories. The higher level of satisfaction would arise from the greater accuracy and timeliness of a computer-based directory. The "cheaper" aspect hinges on the expectation that terminals should be substantially less expensive in quantities of 14 million.

Trials of the new computer-based directories in Brittany have shown that more development work is needed before they can be installed throughout the country, but the PTT is moving ahead with the plan. Curiously, subscriber difficulties with the new system are rather similar to the problems experienced by users of computer-based public access catalogs. Designing inquiry systems that are simple but powerful, that accommodate the needs of typists and nontypists, and so on, remains extremely challenging. The French PTT has not found the job any easier than have designers of library systems.

If we assume that the French PTT eventually will install all those terminals, there should be some interesting ramifications: (1) very inexpensive terminals may be imported into this country, and (2) the telephone may be increasingly used as a substitute for paper mail. As an illustration, suppose you telephone someone who happens not to be in. Why not transmit a short, typed message that could be displayed upon his or her return? It seems likely that the PTT will encourage this kind of use, because in France, the post office does not compete with the phone company. In fact, the PTT has for some time promoted business use of facsimile, which naturally increases telephone revenue at the expense of post office revenue.

If the French experiment is successful, there should be considerable pressure for the introduction of similar technology in this country. It promises to be a bitter fight because the various parties—the Bell System, the USPS, the printing industry—have billions of dollars at stake.

Satellites

Almost forty years ago a science fiction writer described the concept of communications satellites in permanent orbit around the earth. The idea was generally viewed at that time as being about as loony as time travel. Less than two decades later, the Russians shocked the West by launching *Sputnik,* and the space race was on. By any measure, the communications technology that grew out of that race has been a whopping success. Last year the Federal Communications Commission authorized twenty new satellites, which certainly demonstrates that capitalists regard satellites as an attractive venture.

It is not just the launching of more and more satellites that makes this technology significant; satellites are getting bigger, and that will create a whole new range of applications. To illustrate, if you wanted to receive Public Broadcasting System programming directly from the WESTAR satellite, you would need a dish antenna approximately five meters (fifteen feet) in diameter. Such a dish is, naturally, expensive and awkward to install. The next generation of giant satellites will transmit signals so powerful that they can be received using a one-meter dish.* For technical reasons, the one-meter dish will also be suitable for transmitting *to* the satellite. I believe it is only a matter of time until there is a small dish atop the University of Illinois Library providing access to the OCLC network.

Conclusion

A paper dealing with recent developments in technology seems inevitably to drift from indicating trends and making projections into flat-out prophecy. And, of course, prophecies committed to print have a way of making the prophet look foolish. (Alfred Nobel predicted that dynamite was so terrible as to preclude future wars; Henry Ford predicted that the electric automobile would triumph over the gasoline-powered car, and on and on.) My predictions are only two, and to me they seem inescapable. The first is that every advance in telecommunications technology will further erode the autonomy that libraries have traditionally enjoyed. Loss of autonomy is not necessarily an unmitigated evil; it simply means that librarians will need to examine their goals and their resources, and separate the essential from the traditional. The second prediction is that the accelerating pace of technological innovation will make intelligent management of libraries much more difficult. There are many technically complex options open to librarians now—turnkey systems, networks,

*This might be called the Crosley Principle. Crosley sold inexpensive radios during the 1920s and 1930s, and when customers complained that they could not receive anything on their radios, Crosley responded by building the world's most powerful radio station.

public access catalogs, and so on—and the variety and complexity of these options is certain to increase. The librarian who is disdainful of technology will be left behind.